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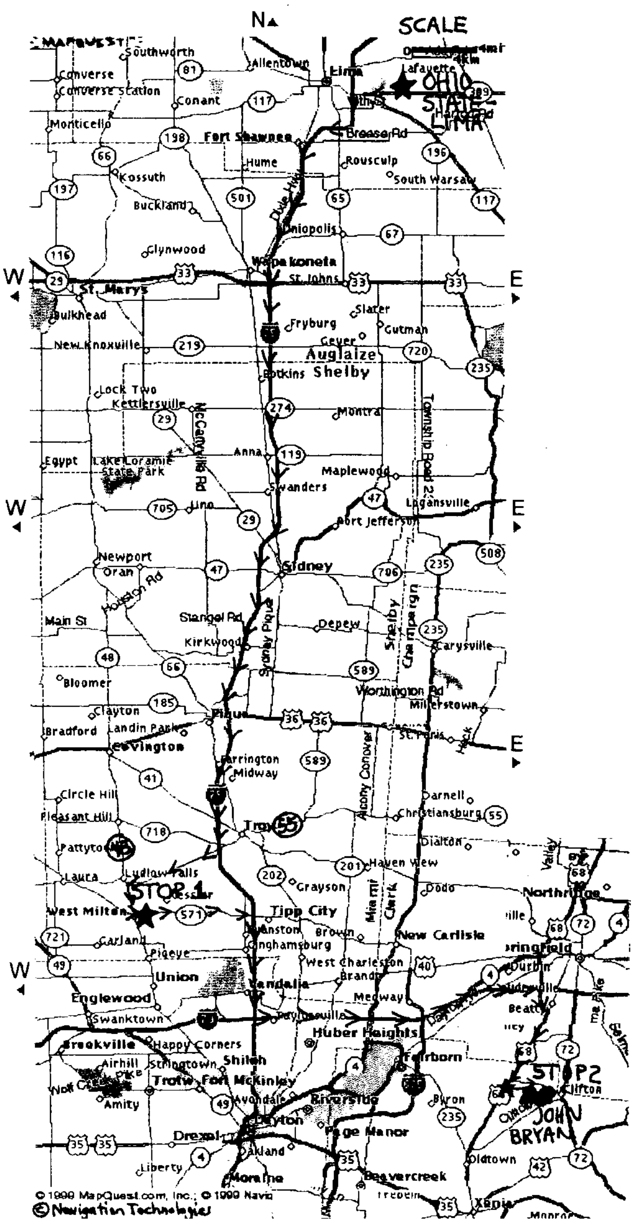
Geology Field Trip

LOWER SILURIAN (LLANDOVERY-WENLOCK) STRATIGRAPHY OF

WEST-CENTRAL OHIO



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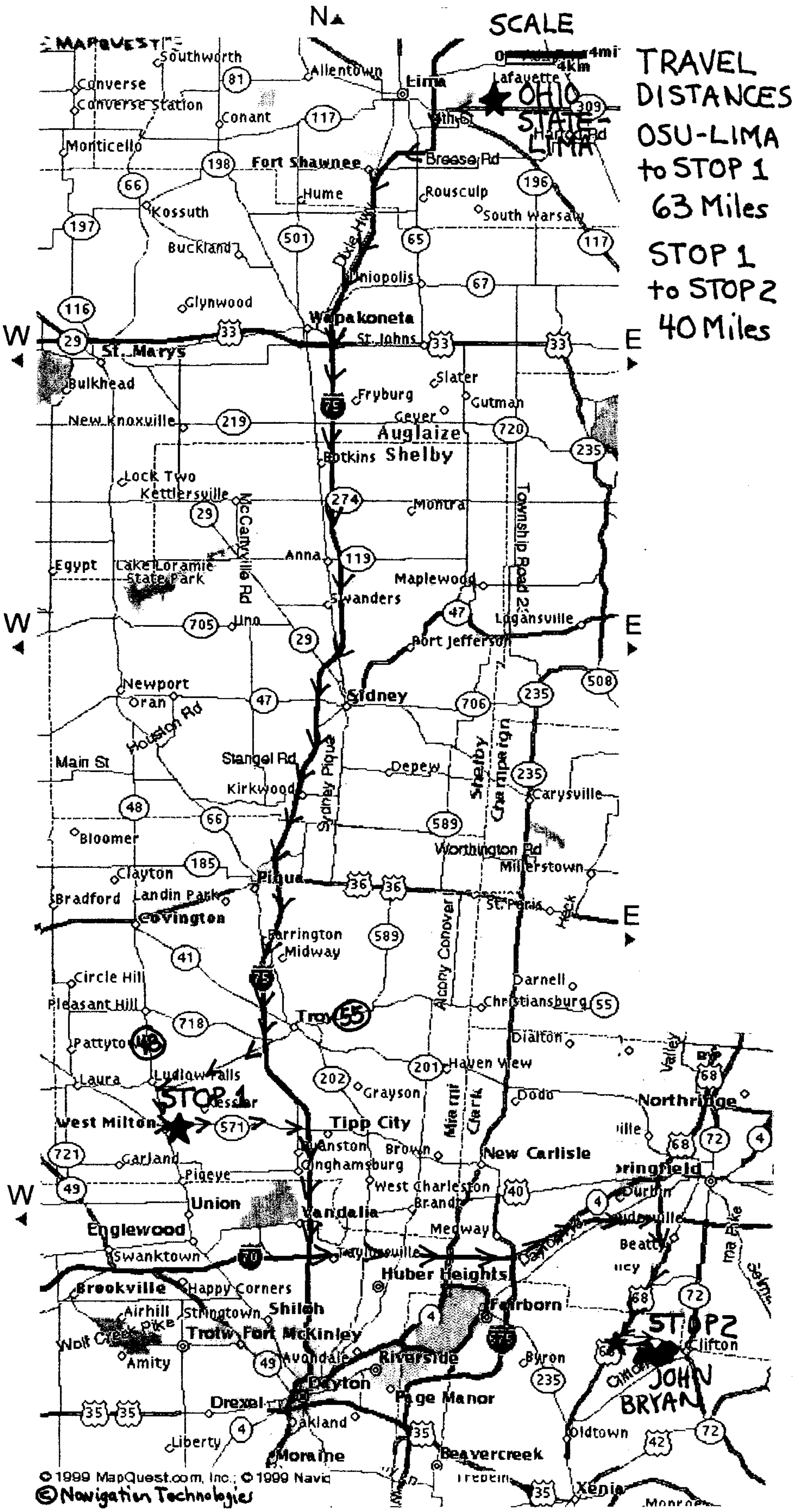

Figure 1. General map of west-central Ohio depicting the driving route for the field trip.

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ITINERARY

STOPS AND TIMETABLE

This guide is for a one-day field trip that has two stops and covers approximately 103 miles from the start to the second stop.

DRIVING DIRECTIONS

Ohio State University at Lima campus to stop 1: Leave The Ohio State University at Lima campus by exiting the parking lot and turning **LEFT** on Biddle Drive. Turn **RIGHT** from Biddle Drive onto Harding Highway (Ohio State Route (OSR) 309). Turn **LEFT** to take I-75 South ramp after traveling about 2.6 miles. Merge onto I-75 South and continue driving on I-75 for approximately 52 miles until reaching the exit for OSR 55. Turn off the interstate at this exit and turn **RIGHT** onto OSR 55 West. Continue following OSR 55 W for about 6 miles until reaching the intersection with OSR 48. Turn slightly **LEFT** onto OSR 48. Continue south on OSR 48 for about 2 miles, at which point OSR 48 also becomes OSR 571. Follow OSR 571 East for about 0.3 miles, or until crossing the bridge over the Stillwater River. STOP 1 is on the right (south) side of OSR, extending about 0.4 miles from the bridge eastward (Figure 2). There should be plenty of parking space along the berm OSR 571 for all vehicles.

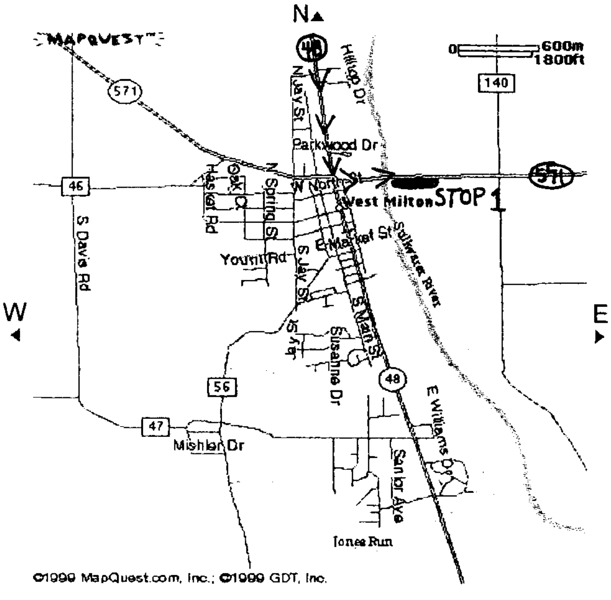

Figure 2. Locality map for Stop 1, roadcut along OSR 571, just east of West Milton, Ohio.

Stop 1 to lunch stop: Merge back onto OSR 571 east. Continue eastbound on OSR 571 for about 7.5 miles, to the entrance ramp to I-75 South. Turn **RIGHT** onto entrance ramp to I-75 South, merge onto I-75, and continue south for about 8 miles to the entrance ramp for I-70 East. Turn **RIGHT** onto entrance ramp and merge onto I-70 East. Continue eastbound on I-75 for about 19 miles, to the ramp for US 68 South. Turn **RIGHT** onto the ramp for US 68 south. Travel about 5.3 miles south on US 68 South until reach entrance for Young's Dairy Barn. Turn **LEFT** into parking lot for Young's Dairy Barn. This is the location where lunch will be (Figure 3).

Lunch stop to Stop 2: Exit parking lot of Young's Dairy Barn by turning **LEFT** onto US 68 South. Continue about 1.5 miles southbound until reaching the intersection with OSR 343. Turn **LEFT** onto OSR 343. Travel about 1.0 mile east on OSR 343 until reaching the intersection with OSR 370. Turn **RIGHT** onto OSR 370 and travel about 1.0 mile south to the entrance to John Bryan State Park. Turn **LEFT** into John Bryan State Park and continue straight on road to parking lot at its end. We will meet in the parking lot and proceed from there on foot to the two sections we will be visiting (Figures 3 and 4).

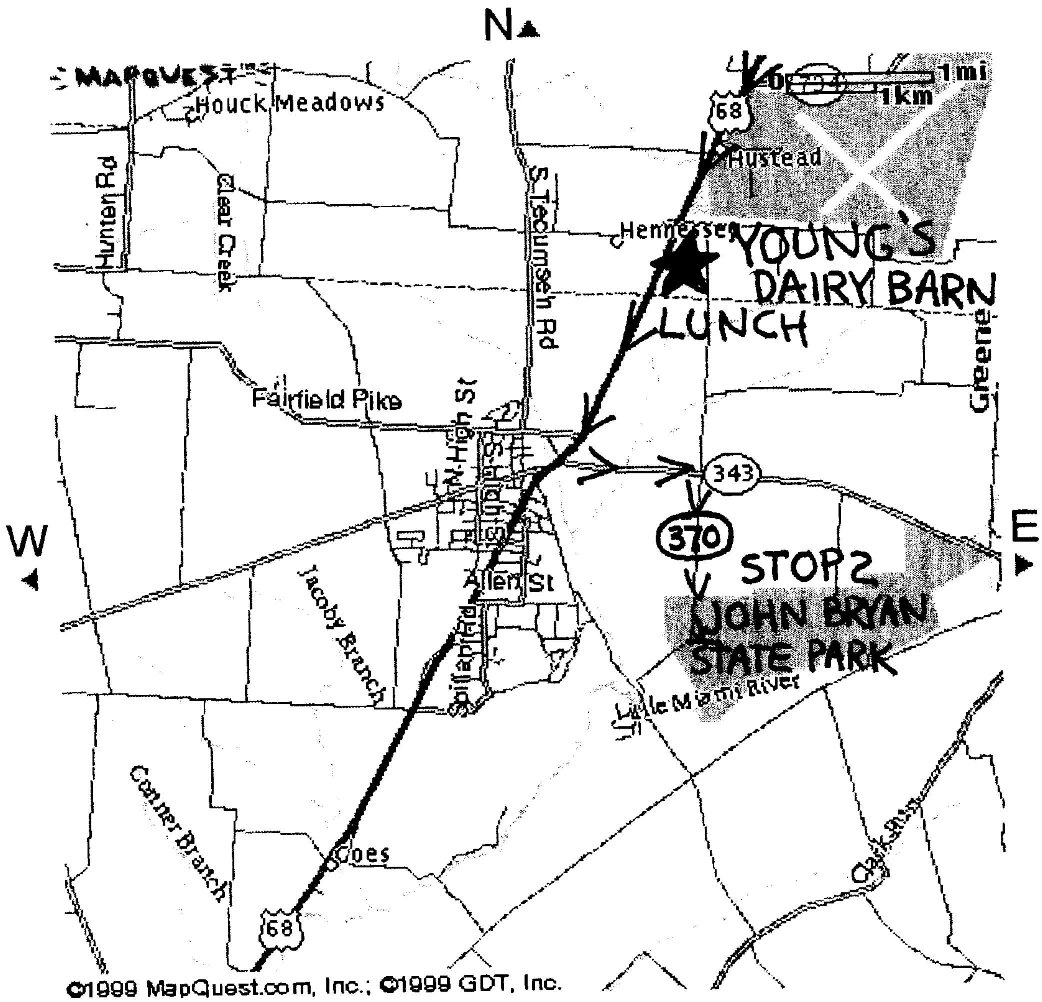

Figure 3. Locality map for lunch stop and Stop 2, John Bryan State Park.

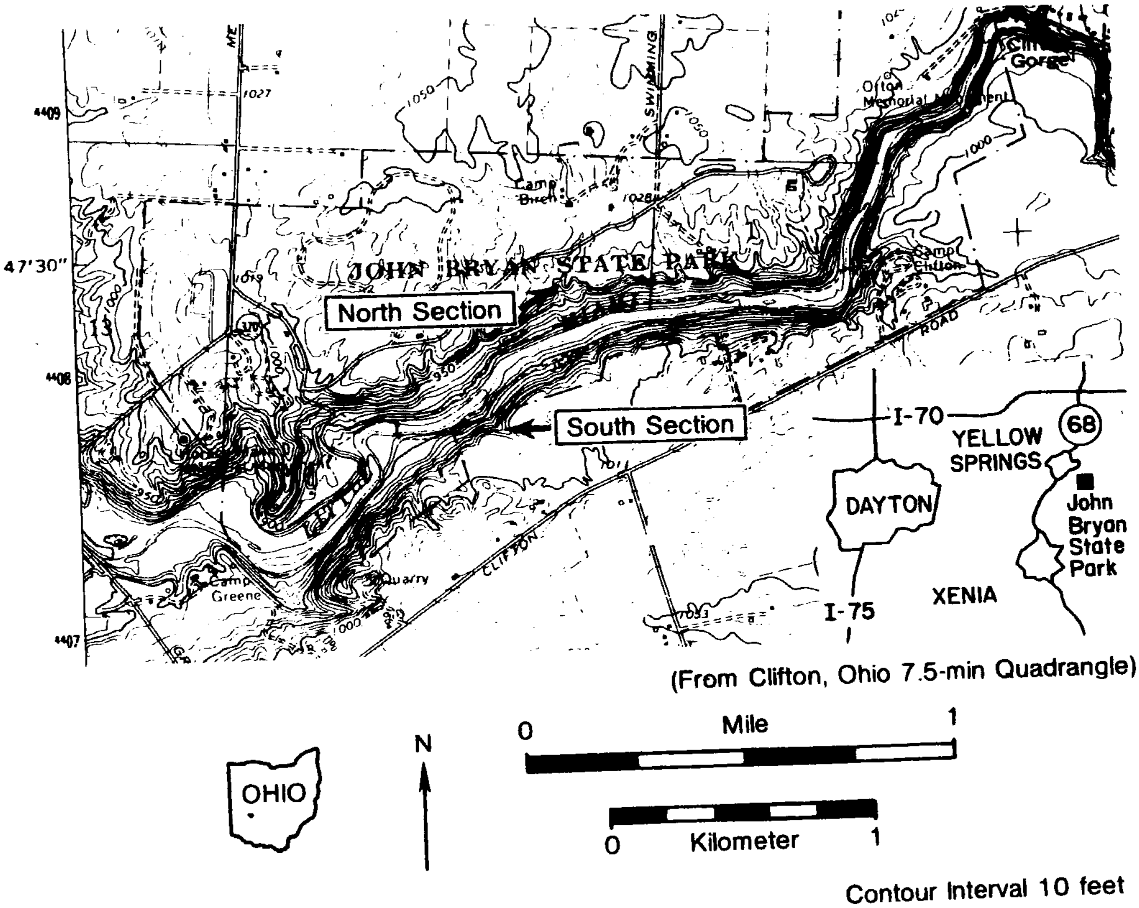

Figure 4. Locality map for Stop 2 at John Bryan State Park. Access to the North and South Sections is by trails along either side of the Little Miami River.

INTRODUCTION

In 1970 Berry and Boucot summarized the stratigraphy of west-central Ohio as was known at that time and correlated it with Silurian strata throughout North America. Conodont distribution in the Lower Silurian was used for the first time by Kleffner (1994) to determine a biostratigraphy for the Lower Silurian of west-central Ohio, which modified and refined the correlations presented by Berry and Boucot (1970). Revision of Silurian conodont taxonomy and revision of the global Silurian composite (Kleffner, 1989) used by Kleffner (1994) for his correlation of these strata (Kleffner, 1995; Kleffner and Barrick, 1996a, 1996b, 1997, 1998, in preparation) since 1994 makes it possible to further modify and revise the previous correlation for the Lower Silurian of west-central Ohio. This field trip will consider a section exposing part of the lower part of the Lower Silurian of Miami County and two sections exposing most of the Lower Silurian of Greene County in west-central Ohio (comparable to the stratigraphy shown in Berry and Boucot, 1970, Plate 2, section 110 and Kleffner, 1994, Figure 2, N.C. Greene County section). From bottom to top, the Lower Silurian in west-central Ohio includes the Centerville Formation, Brassfield Formation, Dayton Formation, Osgood Formation, Laurel Formation, and also probably the Euphemia and Springfield Dolomite and part/all of the Cedarville Dolomite. Present correlation of the Lower Silurian of west-central Ohio is compared to that of Berry and Boucot (1970) and Kleffner (1994) in Figure 5.

GENERAL SETTING

There is one major disconformity (at at least one locality in west-central Ohio, near Fairborn, it is an angular unconformity) within the Lower Silurian of west-central Ohio and possibly two additional (significant?) disconformities. The Lower Silurian is dominated by carbonate deposits in this region. Shale occurs only at the base, in the Centerville, and in the middle, in the Osgood and Laurel. Similarly, only the carbonate beds near the base (Centerville) and in the middle (Osgood, Laurel, and Springfield) contain significant amounts of clay or silt. Carbonate beds in the Dayton, Euphemia, and Cedarville, all above the one major unconformity, are dolomites. Carbonate beds in the Brassfield, one of the two formations below the major unconformity, are limestones or dolomitic limestones. Carbonate beds in the Centerville, where present, are dolomites.

BIOSTRATIGRAPHY

Elements of *Distomodus kentuckyensis* Branson and Branson and *Icriodella deflecta* Aldridge occur in the upper part of the Brassfield in west-central Ohio. This indicates that the formation is within the *D. kentuckyensis* Biozone and is no younger than middle Aeronian in age (Figure 5A). The underlying Centerville Formation, the lowest Silurian unit in Ohio according to Foerste (1931), is tentatively considered to be Rhuddanian in age based on correlation of its chitinozoan assemblage with graptolites as discussed in Grahn and Bergstrom (1985; their Belfast Member of the Brassfield is largely the Centerville Formation, as recognized by Foerste, 1931, and Kleffner and Riddle, 1990). Although not possible at present to demonstrate conclusively, because of the current resolution (or lack thereof) afforded by any biostratigraphy (conodont, graptolite, chitinozoan, acritarch, brachiopod) for Centerville and Brassfield strata of west-central Ohio, the Centerville/Brassfield boundary is likely a disconformity (Figure 5A). Elements of *Pterospathodus amorphognathoides amorphognathoides* Walliser occur first in the upper middle Dayton and occur last in the lower part of the Osgood, indicating that the Dayton and lower Osgood are within the *P. amorphognathoides* Biozone and late Telychian (latest Llandovery) to early Sheinwoodian (earliest Wenlock) in age (Figure 5A). The Brassfield/Dayton contact is thereby a major unconformity representing most of late Llandovery time (late Aeronian and early (and also late?) Telychian time).

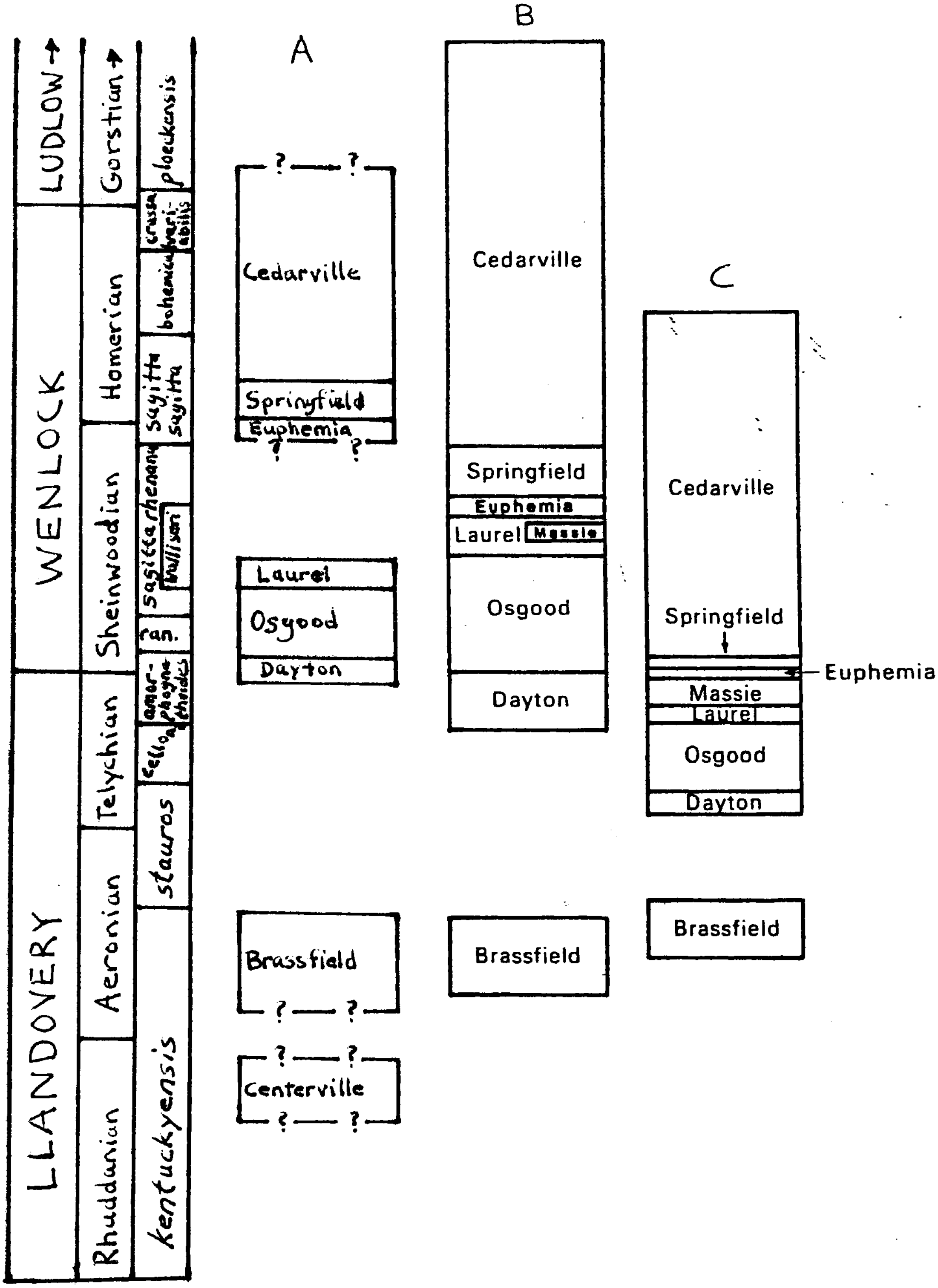

Figure 5. A. Correlation of the Lower Silurian of west-central Ohio, revised for this field trip. B. Correlation of the Lower Silurian of north-central Greene County presented by Kleffner (1994). C. Correlation of the Lower Silurian of west-central Ohio presented by Berry and Boucot (1970). *Ran.* = *ranuliformis*.

Elements of *Kockelella ranuliformis* (Walliser) occur in all Osgood samples above those that contain elements of *Pterospathodus amorphognathoides amorphognathoides*, and elements of *K. walliseri* (Helfrich) occur first in the overlying basal Laurel. All but the lowest Osgood is thus within the *K. ranuliformis* and lower part of the *Ozarkodina sagitta rhenana* Biozone and early Sheinwoodian in age (Figure 5A). Elements of *Kockelella walliseri* are found throughout the entire Laurel, including the Massie Shale Member. The entire Laurel is thereby late early Sheinwoodian in age (Figure 5A).

It is difficult to determine a conodont biostratigraphy for the Euphemia, Springfield, and Cedarville Dolomites, since none of them has yet yielded diagnostic conodonts (or any other high-resolution age-diagnostic fossils). *Kockelella variabilis* is possibly represented in the upper part of the Cedarville at one locality in west-central Ohio. If that species is indeed represented in that part of the Cedarville, and is its lowest representation in west-central Ohio, then at least the upper part of the Cedarville would likely be within the *Ozarkodina? crassa/ K. variabilis* Biozone and either late Homerian (latest Wenlock) or possibly early Gorstian (earliest Ludlow) in age. There is a distinct lithologic (and likely facies change, although it is all dolomitized) change across the Laurel/Euphemia boundary. It is quite possible that this boundary is another unconformity. Discontinuous zones of pentamerid brachiopods at the lower and upper contacts of the Springfield Formation (Ausich, 1987), compared to the distribution of pentamerid brachiopods in the Lower Silurian in Gotland (Jeppsson, 1997) might indicate that the Springfield Dolomite is within the *Ozarkodina sagitta sagitta* Biozone. If that is correct, then because of the conformable nature of the Euphemia/Springfield boundary, and since the Euphemia is such a thin unit (typically no more than 2.0 m in thickness), it is possible that the Laurel/Euphemia boundary represents the middle and upper part of the *Ozarkodina sagitta rhenana* Biozone (and also the lower part of the *O. sagitta sagitta* Biozone?) (Figure 5A). This boundary would then represent late Sheinwoodian and perhaps earliest Homerian time (Figure 5A). Although quite tentative, the Springfield and Cedarville Formations are shown to range from late early Wenlock through early Ludlow in age, based on the possible representation of the *Ozarkodina sagitta sagitta* Biozone in the Springfield and the possible representation of the *O.? crassa/Kockelella variabilis* Biozone in the upper part of the Cedarville (Figure 5A).

DESCRIPTION OF STOPS

STOP 1 -- WEST MILTON, OHIO, ROADCUT

Only the lower part of the Lower Silurian sequence of west-central Ohio is exposed at this stop. The upper approximately 3.5 m of the Brassfield Formation and the lower approximately 3.0 m (which is perhaps nearly its entire thickness) of the Dayton Formation are exposed in this approximately 0.6 km-long roadcut, which is located 0.5 to 1.1 km east of the intersection of OSR 517 and OSR 48 in West Milton, just east of the Stillwater River (North edge NW 1/4, NE 1/4 sec. 21, T. 7 N, R 5 E, West Milton U.S.G.S. 7 1/2-minute Quadrangle, Miami County, Ohio) (Figure 2). The general lithology of the Brassfield and Dayton exposed at this locality is fairly comparable to their lithologies at the two sections at Stop 2 (Figure 6). The lower part of the Brassfield, underlying Centerville, and perhaps even underlying Upper Ordovician strata are possibly present, but covered, in the interval from the base of the exposed Brassfield to the level of the Stillwater River just to the west.

The lower part of the Brassfield exposure at this stop is a white- to orange-colored crinoid grainstone, with fewer obvious whole (or nearly so) macrofossils. The upper Brassfield is an orange- or pink-colored crinoid-bryozoan grainstone, much like the Brassfield exposed at John Bryan State Park. However, unlike John Bryan State Park, the upper 2.0 m or so of Brassfield at this locality include many small bryozoan reef mounds (12 bryozoan bioherms are recognized by Moore and others, 1999). The bryozoan reef mounds are all no larger than 1.3 m high by 3.0 m wide (Moore and others, 1999). The tops of most, if not all, of the small reefs are located within 0.5 to 1.0 m of the Brassfield/Dayton contact. The small reefs consist of green-gray massive marlstone packed with large branching bryozoans; recrystallized stromatoporoid crusts and tabulate corals are also found in a few of the reefs (Moore and others, 1999). Brachiopods also occur in the upper part of the Brassfield. Samples from the Brassfield at this stop have not yet been processed for conodonts or any other microfossils.

The contact between the Brassfield and overlying Dayton is marked by an abrupt lithologic change, discontinuous shale laminae or a very thin shale bed separating the two formations, and by at least a little relief. The basal Dayton is a sparsely fossiliferous grayish-white dolomicrite. The remainder of the Dayton at this stop has not been studied in detail yet. Samples from the Dayton at this locality have not yet been processed for conodonts or any other microfossils. Since no biostratigraphy has been developed for the Brassfield and Dayton at this locality yet, it is not possible to state for certain whether the Brassfield/Dayton contact here is a major unconformity of the same extent as at the South Section of Stop 2, which is typical for the Brassfield/Dayton contact for much of west-central Ohio.

STOP 2 -- JOHN BRYAN STATE PARK

(Much of this text was taken from Kleffner and Ausich (1988), a field trip guide by for the Fifth Midyear Meeting of SEPM)

The entire Silurian stratigraphic section of Greene County, Ohio, is well exposed in John Bryan State Park along walls of the gorge cut by the Little Miami River. Rocks are best exposed in two sections (Ausich, 1987): North Section, NW 1/4, SW 1/4, NW 1/4, Sec. 1, T. 4, R. 8; South Section, SE 1/4, NW 1/4, SE 1/4, Sec. 1, T. 4, R. 9; Clifton, Ohio U.S.G.S. 7 1/2' topographic quadrangle (Figure 4). Access to both sections is from a trail that starts at the lower picnic area of the park.

The Silurian is recorded by seven formations (Figure 6), that from bottom to top are the Brassfield Formation, Dayton Formation, Osgood Formation, Laurel Formation (with the Massie Shale Member), Euphemia Dolomite, Springfield Dolomite, and Cedarville Dolomite.

Approximately 8.0 m of Brassfield have been reported from this part of Greene County (Stith and Stieflitz, 1979). In John Bryan State Park, the upper 7.4 m (almost all) of the Brassfield are exposed. Petrographically the Brassfield is a crinoid-bryozoan grainstone throughout. Bedding is lenticular, bed thicknesses range from 2 to 30 cm, and the rocks are very fossiliferous. The upper Brassfield is exposed at both the North and South Section.

Disarticulated crinoidal remains, bryozoans, trilobites, brachiopods, corals, and stromatoporoids are common macrofossils. Macrofossils are not readily collected from the Brassfield at John Bryan, but elsewhare in Greene County the paleontology and petrology of the Brassfield has been well studied. Laub (1979) described the Brassfield coral fauna, including specimens from Greene County localities. Foerste (1919) described the first Brassfield crinoids, recognizing only a few taxa. In a series of papers, Ausich (e.g. 1984, 1986) described an extensive, largely new, crinoid and cystoid fauna from the Brassfield. The echinoderm fauna of Greene and Montgomery Counties is now recognized to contain 30 crinoid species assigned to 28 genera, and it is the most diverse Lower Silurian crinoid fauna known. Conodonts are common to abundant in Brassfield residues. Representatives of eight genera are now recognized.

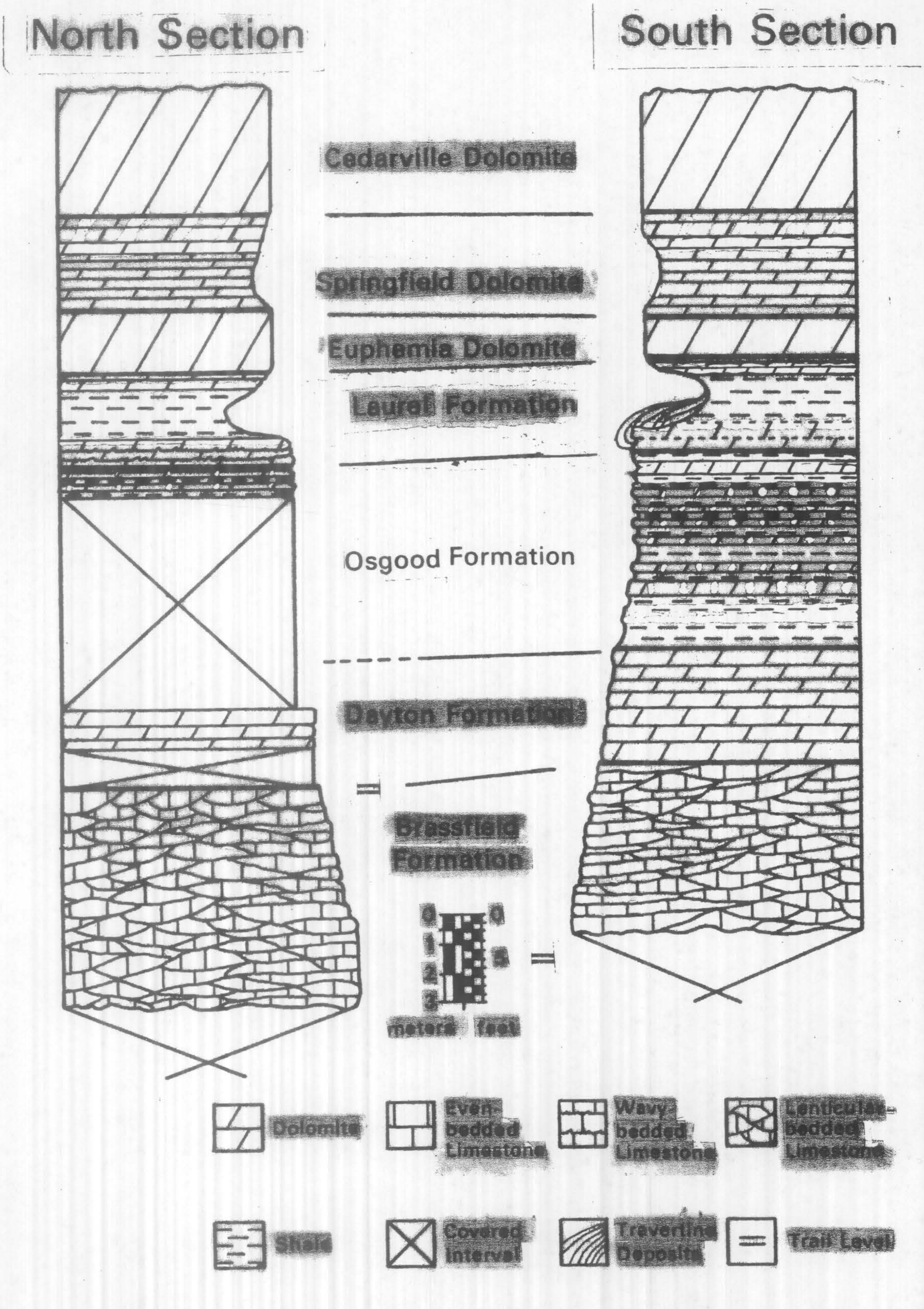

Figure 6. Stratigraphic sections for the North and South Sections at Stop 2, John Bryan State Park. Note the position of the trail level in each section. The Brassfield and Dayton at both sectons in John Bryan State Park are lithologically quite comparable to the 3.5 m of Brassfield and 3.0 m of Dayton exposed at Stop 1. Modified from Ausich (1987).

The Dayton Formation is a coarsely crystalline, even-bedded dolomite 3.8 m thick. In the South Section a thin shale is present between the Brassfield and Dayton. Dolomitization was secondary; crinoids, corals, cephalopods, and bryozoans have been reported from the Dayton (Foerste, 1935). Macrofossils are not readily collected from the Dayton at John Bryan, as dolomitization was apparently quite pervasive. Microfossils are common only in the upper part of the formation and are mostly conodonts. Nine species assigned to eight genera are recognized.

The Osgood Formation is interbedded blue-gray silty shales and recrystallized dolomicrites. It is 6.7 to 8.1 m thick, with shale dominating in the lower three-quarters of the formation and dolomicrite in the upper quarter. The Osgood was at one time completely exposed at the South Section, but the lower part is now covered. Burrow mottling, echinoderm fragments, gastropods, and pelecypods are present in the dolomites of the Osgood, and shales contain crinoids, bryozoans, brachiopods, gastropods, trilobites, and corals. Brachiopods and corals were reported from the Osgood by Foerste (1935). Microfossils are common in dolomites and shales and includes conodonts and ostracodes. The conodont fauna of the Osgood in John Bryan is now recognized to contain 15 species assigned to 11 genera.

The Laurel Formation is a recrystallized, dolomitized crinoid packstone, with a dark blue-gray shale generally in its middle part. The entire formation is 2.5 m thick and has average bedding thickness of 10 cm. It is exposed better at the North Section. The Massie Shale Member is a 1.5 to 1.7 m thick dark, blue-gray shale that is best exposed at the North Section. Previous authors (Foerste, 1935; Ausich, 1987) have considered the Massie to be a separate formation. Kleffner (1994) recognized the Massie as part of the Laurel due to its limited geographic extent, the presence of beds of Laurel-like lithology above the Massie, and the conodont fauna of the Laurel and Massie. Macrofossils in the Laurel include crinoids, brachiopods, corals, and gastropods. Microfossils are more abundant than macrofossils and include conodonts, ostracodes, and tentaculitids. Rare crinoids, bryozoans, and brachipods are present in the Massie Member at the North Section. Elsewhere in the park, gastropods, trilobites, and corals have also been reported from the Massie (Kleffner, 1988). Eight conodont species assigned to seven genera are represented in the Laurel.

Dolomites characterize the remainder of the Lower Silurian section at John Bryan. The Euphemia Dolomite is a dolomitized echinoderm packstone that varies in thickness from 1.3 to 2.0 m. In John Bryan it is well exposed at both the North and South Sections, and it is a massive dolomite. Busch (1939) recognized representatives of 31 macrofossil species in the Euphemia, 19 of them representing brachiopods. A discontinuous zone of pentamerid brachiopods in life position is present within a few centimeters of the Euphemia/Springfield contact (Ausich, 1987). This zone can be located along the trail at the base of the gorge highwall. Microfossils are rare in the Euphemia, and only one conodont species, a long-ranging form, is currently recognized from the Euphemia.

The Springfield Dolomite contrasts with the Euphemia below and Cedarville above. The Springfield is a dolomicrite that is averages about 3.2 m in thickness. It is even-bedded throughout (bed thickness averages 10 cm), has a relatively high quartz silt insoluble residue (Stout, 1941; Elliot, 1984), and is very sparsely fossiliferous. Rare pentamerids are scattered throughout; ostracodes and conodonts are also present. As with the Euphemia, only one long-ranging conodont species is currently recognized from the Springfield. The Springfield Dolomite is well exposed at both the North and South Sections and at the base of the gorge highwall throughout the park and in part of the adjacent Clifton Gorge State Nature Preserve. In a naturally weathered exposure, the even-bedded Springfield typically forms a slight reentrant between the Euphemia and Cedarville.

The Cedarville Dolomite is very similar in composition and fossil content to the Euphemia Dolomite. A discontinuous zone of pentamerid brachiopods in life position is also present near the contact of the Springfield and Cedarville (Ausich, 1987). The lower 5.4 m of the Cedarville is present at John Bryan State Park. The adjacent Clifton Gorge Nature Preserve, upstream and eastward, exposes more of the Cedarville. The entire Cedarville is exposed at a quarry in Cedarville, 7.0 km south of John Bryan State Park, and is 25.5 m thick. Similar to the Euphemia, the Cedarville contains a diverse marine fauna and few conodonts (although as mentioned previously, perhaps the age-diagnostic *Kockelella variabilis* is represented in strata at the quarry in Cedarville). Brachiopods, crinoids, cystoids, and corals are present.

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